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7. The temporary atresia of the esophagus in the *Caretta* embryo would appear to be a device for the protection of the lung during its development against yolk material from the gut; which material could not be digested but would interfere with normal development of the lung.

8. This hypothesis can comprehend and correlate conditions in embryos of forms with meroblastic, homoblastic telolecithal, and alecithal eggs. Where yolk is very abundant as in the meroblastic eggs of fishes, reptiles and birds, the atresia is relatively extensive and of longer duration; in amphibia the closure is largely of the nature of a stenosis in which yolk globules are involved, probably in process of digestion while their forward progress is delayed by reason of the constricted lumen. In most mammals and in man such mechanism is functionally superfluous, and consequently absent except in slight and variable degree. As such it may persist or become accentuated, and produce congenital atresia or stenosis of the esophagus.

A more detailed description will appear in Publication No. 251 of the Carnegie Institution of Washington.

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STUDIES OF MAGNITUDES IN STAR CLUSTERS, V. FURTHER EVIDENCE OF THE ABSENCE OF SCATTERING OF LIGHT IN SPACE

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The interest and importance attached to an accurate quantitative knowledge of the scattering of light in space, for all studies of the extent and character of the stellar universe, has been commented upon by various writers, particularly by Professor Kapteyn. In the first communication of this series[1] the matter was discussed briefly and evidence was presented showing that interstellar space, at least in the direction of the Hercules cluster, is free of the kind of light absorption that modifies the color of the stars. The generalization of this hypothesis into the conclusion that such light scattering is practically negligible in all parts of the sky awaits, first, the verification of the original observational result; second, the confirmation of the proposed physical interpretation of such data; and, finally, an investigation of the faint and most distant stars in a wide range of galactic latitudes and longitudes. The present note contains a further contribution to the subject and permits a fairly definite solution.

In the first study of the magnitudes of the stars in the Hercules cluster normal values of color indices were obtained. Among a thousand objects no abnormally large or small values were found; and among the fainter stars, photovisual magnitude 14 to 16, a great number of negative indices appeared. The essential correctness of this result has now been checked in two different ways—by a new series of polar comparisons, and through a determination of the color indices by the method of exposure ratios.[2]

Assuming the observed colors to be reliable, the presence of negative color indicates two significant conditions, namely, the absence of light scattering, and the great distance and size of the cluster. There appears to be no adequate reason for modifying this adopted interpretation of the blue faint stars. The decrease in the intensity of light by terrestrial atmospheric scattering is known to vary inversely as the fourth power of the wave length. The dissipated atmospheres and meteoric dust, to whose agency spatial light attenuation is commonly ascribed, are recognized as similarly capable of the preferential scattering of blue light. Such a differential light absorption certainly would make all stars appear redder. The presence of very blue stars, therefore, points to the inefficiency of the light-scattering residue in space, provided the objects involved are sufficiently remote. As all studies of B-type stars (negative color indices) indicate a high absolute luminosity and relatively small dispersion around a mean value, such stars, when apparently faint, are an immediate and apparently reliable index of great distance, and distance is the most important factor in testing the scattering of light in space.[3]

The systematic increase of redness observed toward the center of the Hercules cluster[4] may be interpreted as a spurious effect caused by the crowding of images on the photographic plate, or as a scattering of light in the denser portion of the cluster itself. The former is almost surely the true explanation. The possibility, however, that the latter cause contributes, suggests that the absence of light absorption in the direction of the Hercules cluster does not imply an inappreciable absorption in the lower galactic latitudes where stellar material apparently is much more concentrated. Accordingly it becomes appropriate to investigate clusters in the Milky Way and the faint stars in the galactic clouds. The presence of negative color indices, or a normal range of color, in such regions, assuming of course the distances to be great, will indicate the essentially complete transparency of space throughout the whole stellar system.

The position, with respect to the galactic plane, of the fields in which magnitudes and colors have been studied in the course of this work are listed in the following table. With two or three exceptions the regions are in or around stellar clusters. The fourth and fifth columns give for each region the limiting values of the color indices. In several of these fields the survey is not yet complete, and values somewhat larger and smaller may be found later. This applies especially to Messier 5 and Messier 3, for which the magnitudes of the fainter and probably more typical b-class stars are not yet available. The sixth and seventh columns give for each region the mean photovisual magnitude and mean color index of a group of the faintest blue stars. The average number in each group is ten.

PRELIMINARY RESULTS BEARING ON THE EXTENT OF THE GALACTIC SYSTEM

REGION	GALACTIC LONGITUDE	GALACTIC LATITUDE	OBSERVED COLOR INDEX		AVERAGE P_V MAG.	AVERAGE COLOR INDEX	PARALLAX	
			Largest	Smallest			M = 0	M = +2
Messier 3*...............	12°	+78°	+1.77	−0.39	15.1	−0.16	0″0001	0″00024
Messier 13*..............	27	+40	+1.42	−0.52	16.54	−0.34	0.00005	0.00012
Messier 15*..............	33	−28	+1.50	−0.21	16.0	−0.14	0.00006	0.00016
XX Cygni**.............	60	+13	+1.33	−0.14	12.64	−0.02	0.0003	0.0007
In Lacertae..............	69	− 3	+1.58	−0.37	12.65	−0.01	0.0003	0.0007
Messier 38...............	139	+ 1	+2.12	−0.45	13.5	−0.16	0.0002	0.0005
Messier 36...............	142	+ 1	+1.50	−0.30	12.5	−0.23	0.0003	0.0008
Messier 35...............	154	+ 3	+1.31	−0.15	11.5	−0.07	0.0005	0.0013
Messier 50...............	189	− 1	+2.00	−0.04	12.3	−0.02	0.0003	0.0009
Messier 5*...............	332	+46	+1.67	−0.11	14.6	−0.10	0.0001	0.0003
Near M 11...............	354	− 3	+2.23	−0.42	14.2	−0.14	0.00015	0.00036
Messier 11...............	355	− 3	+2.06	−0.16	14.32	−0.08	0.00014	0.00034
Near M 11...............	356	− 4	+1.81	−0.14	13.9	−0.01	0.0002	0.0004

*Globular cluster. **Three stars.

The accidental errors affecting the colors are so small that the dispersion of color index and the negative and small positive values of the index cannot be attributed to observational uncertainty. The systematic errors have been carefully examined for several of these regions and they are similarly inadequate, at least as far as our present knowledge of them extends. The blueness of the faint and distant stars, thus shown to exist for numerous directions in space, may be accepted, therefore, as an indication of the general ineffectiveness of differential light scattering. This result also naturally implies the absence of all diminution of the intensity of light through the agency of interstellar media.

The daily encounter of the earth with millions of meteors is frequently cited as evidence of the prevalence of highly efficient light-scattering and light-obstructing material throughout interstellar space. If, as seems likely, the meteoric dust, which is closely allied to the meteoric streams and comets, is a definite and original part of the solar system and is not cosmic in origin and motion, this argument loses its force; and whatever extinction of light such matter produces, either in the solar system or in immediate gravitational field of other stars, is wholly unimportant in its bearing on stellar distribution and distances.

Disregarding light absorption, we may compute for each region the parallax of stars of the tabulated mean photovisual magnitude, as soon as we know the mean absolute luminosity corresponding to the average color. Upon the basis of the researches of Kapteyn, Russell, Charlier, and others, we make two assumptions for the mean absolute magnitude of the blue stars, $M = 0$ and $M = +2$, and compute the results given in the last two columns of the table. For the globular clusters the smaller parallaxes are undoubtedly preferable, since in these systems we are certainly treating only the brightest of the bluer stars. Moreover, the smaller value is in keeping with results derived by means of variables and other stars of high luminosity. For the open clusters the larger values of the parallax are probably better. In a few of the regions, however, the magnitudes and colors are provisional; and the adopted mean absolute magnitudes of B-type stars, though not improbable, are of course somewhat uncertain. Hence the estimates of the extent of the galactic system (including its open clusters), and the indications of the relatively greater distances of the globular clusters, are here proposed as only preliminary results; their main value lies in the definite evidence of the vast dimensions of the visible stellar universe and in the problems suggested for further investigations along this line.

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[1] Shapley, H., these PROCEEDINGS, **2**, 1916, (12–15).

[2] Seares, F. H., *Ibid.*, **2**, 1916, (521–525).

[3] Shapley, H., *Mt. Wilson Contrib.* No. 116, 1915, (1–92), pages 52–58 and 88.

[4] *Ibid.*, pages 58–61.